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lar to the line joining the centers of the given circles. This offers no difficulty and the problem is solved.

Also solved by *ELMER SCHUYLER, HALLET E. McCLINTOCK;* and *CHARLES C. CROSS.* Professor Young furnished a neat diagram to accompany his solution of Problem 131.

CALCULUS.

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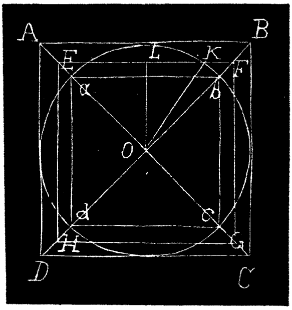
99. Proposed by **L. C. WALKER**, Associate Professor of Mathematics, Leland Stanford Jr. University, Palo Alto, Cal.

The axis of three equal right circular cylinders intersect at right angles. Find the volume of the solid common to all.

Solution by **G. B. M. ZERR, A. M., Ph. D.**, Professor of Mathematics and Science. Chester High School Chester, Pa.

Let $x^2+z^2=a^2$, $y^2+z^2=a^2$, $x^2+y^2=a^2$ be the equations of the cylinders. The projection of the intersection of the first and second on the plane xy is a square.



From $z=0$, to $z=\frac{1}{2}a\sqrt{2}$ the square decreases from $ABCD$ to $abcd$. The area of the projection common to the three cylinders between $z=0$ and $z=\frac{1}{2}a\sqrt{2}$ is eight times the area $LObKL$. From $z=\frac{1}{2}a\sqrt{2}$ to $z=a$ the common volume is the same as the volume common to the first and second.

Let $\angle LOK=\theta$. Area $EFGH=4xy=4(a^2-z^2)$.

Area $LOK=\frac{1}{2}a.OL\sin\theta=\frac{1}{2}ay\sin\theta$.

Area $KOb=\frac{1}{2}a^2(\frac{1}{4}\pi-\theta)$.

$\tan\theta=LK/OK=x/y=\sqrt{(a^2-y^2)}/y=z/\sqrt{(a^2-z^2)}$;

$\therefore \sin\theta=z/a$. $\therefore$ area $LOK=\frac{1}{2}z\sqrt{(a^2-z^2)}$, area $KOb=\frac{1}{2}a^2(\frac{1}{4}\pi-\sin^{-1}z/a)$.

$$\therefore V=8\int_0^{\frac{1}{2}a\sqrt{2}}[z\sqrt{(a^2-z^2)}+a^2(\tfrac{1}{4}\pi-\sin^{-1}z/a)]dz+8\int_{\frac{1}{2}a\sqrt{2}}^{a}(a^2-z^2)dz,$$

$$=8a^3(2-\sqrt{2}).$$

Also solved by *PROFS. ANDEREGG, SHERWOOD,* and *SCHMITT.*

100. Proposed by **B. F. FINKEL, A. M., M. Sc.**, Professor of Mathematics and Physics, Drury College, Springfield, Mo.

What is the volume bounded by the surface generated by the circumference of a circle whose diameter is the hypotenuse of a right-angled triangle whose base is b and altitude a, the plane of the circle being perpendicular to the plane of the triangle, the triangle and circle being rigidly connected, and the triangle revolving about its altitude a as an axis?

Solution by **F. ANDEREGG, A.M.**, Professor of Mathematics, Oberlin College. Oberlin, O., **H. C. WHITAKER, Ph. D.**, Professor of Mathematics, Manual Training School. Philadelphia, Pa.; **G. B. M. ZERR, A. M., Ph. D.**, Professor of Mathematics and Science, Chester High School, Chester, Pa.; and the **PROPOSER.**

Let $AB=a$, $OA=b$, $AC=\sqrt{(a^2+b^2)}$; the coördinates of P and point in